

CHK Technical Review

E & E Technical Memorandum – Installation of groundwater monitoring wells in support of EPA's hydraulic fracturing study.

Executive Summary:

Chesapeake Energy (CHK) has prepared these comments in response to E&E's two technical memorandums prepared for the EPA and transmitted to CHK on March 1, 2012 and March 27, 2011 via email. CHK's detailed response is formatted to follow the technical memorandums; the first bullet paraphrases language from the memorandum and sub-bullets represent CHK comments. General comments are highlighted below:

- Chesapeake Energy understands that the Option #1 (vertical well with off pad access) proposed in the original technical memorandum has been removed as a viable alternative.
- The installation of horizontal monitoring wells after the production well has been installed significantly mitigates the potential risk to the monitoring wells' integrity, and, therefore, the study.
- The limitations of the horizontal monitoring wells require additional consideration to ensure the study's data quality objectives will be met. For example, the fluctuation in groundwater levels and end data use (i.e., modeling) should have specific considerations identified.
- CHK recommends EPA identify the process it will use to differentiate between potential causes (including naturally occurring) should sampling results indicate a significant change in water quality that is otherwise unexplainable.
- CHK does not believe the site characterization activity identified by the EPA will provide the information necessary to determine the groundwater velocity in the deeper bedrock formation.
- Appropriate monitoring well abandonment procedures for non-standard well should be developed.

CHK understands EPA's rationale for using non-standard wells on this highly influential scientific assessment stems from an EPA schedule issue related its 2014 report. CHK has worked with the EPA to identify a second site with what we believe to have favorable groundwater velocity. Based on characterization of the aquifers, the use of horizontal monitoring wells may not be necessary to achieve EPA's study goals.

Detailed comments:

Re: Technical Memorandum – Installation of groundwater monitoring wells in support of EPA’s hydraulic fracturing study. (February 24, 2012).

Introduction:

- E&E limited the scope of the study to underground sources of drinking water (USDW), which has a specific definition under the Safe Drinking Water Act (SDWA) (i.e., 10,000 mg/L TDS). The State of OK has defined the base of treatable water (i.e. TDS of 10,000 mg/L) in this area at occurring between approximately 100 to 150 ft below ground level (bgl)., however, the E&E/EPA have proposed monitoring wells at depths up to 300 ft. The Final Study Plan does not limit the boundaries of the study to USDW.
 - EPA should develop clear boundaries for the study. It is recommended EPA use and clearly state that USDW are the boundaries of the study, and not install monitoring wells into zones that have naturally occurring brine or salt water present (TDS >10,000 mg/L)..
 - During the March 23, 2012 meeting, EPA stated it used 300 ft. because CHK previously stated this value as the depth of groundwater in this area. CHK believes it is important that EPA independently validate information (or secondary data) provided by CHK or others in accordance with EPA project specific data quality objectives, QMP, and QAPPs. The 300 ft. value was stated early in the site selection process as an approximation for the depth of USDW in the Mississippi Lime Play, but the Oklahoma Corporation has developed accurate depth to treatable water maps for this specific site, and those maps should be evaluated and used appropriately
- E&E acknowledges that the proposed alternatives are non-standard groundwater monitoring wells.
 - CHK recommends the use of standard vertical groundwater monitoring wells on this study in order to reduce the risk to the study associated with the application of non-standard monitoring wells.
- E&E states that this is a natural gas well pad. This statement is made throughout the memo.
 - This well is not considered a natural gas well. The Mississippi Lime is an oil play.

Background:

- E&E has assumed a 400 ft. by 400 ft. pad, and the ability to install the well approximately 75 ft. from the production well.
 - More accurate well pad dimensions will be provided to the EPA at a later date. There are a number of variables that dictate the size of the pad (i.e., drill rig, number of wells, etc.). Conservative dimensions for the pad are 350 ft. by 400 ft.

- Note that orientation of the pad will not be necessary if EPA plans to use horizontal monitoring wells. The adjustment will impact CHK's operations, and was offered to facilitate the installation of conventional monitoring wells off the pad location.
- E&E states that piezometers will be used to determine actual subsurface conditions, including groundwater flow direction, depth to water and depth to bedrock.
 - The limitations of the geo-probe scope of work should be disclosed in terms of the information that will be able to be collected. For example, the piezometer will not be able to determine conditions (i.e., groundwater velocity) for the proposed deep monitoring well in the bedrock formation. It has now been agreed that conventionally drilled monitoring wells will be used in lieu of geo-probe installed wells.
- E&E referenced a 300 ft. exploratory boring (off-pad) to determine the presence or absence of water bearing zones in bedrock.
 - "Water bearing zones" need to be clearly defined (e.g., USDW). The quality and quantity of water is of interest.
 - EPA should set limits, in terms of monitoring drilling capabilities (i.e., accuracy of location), for target water bearing zones.
- The depths of proposed down gradient monitoring wells are stated as 20 ft. (top of the water table), 50 ft. (base of the unconsolidated aquifer), and 300 ft. (within the underlying shale formation).
 - It is understood that E&E made assumptions based on previous conversations, however, CHK would like the methods for determining the depths of the monitoring wells to be clearly stated and the use of best available information to be assured. For example, the top of the water table changes based on seasonal variations and water use, and the underlying bedrock formation varies greatly with depth, and the water quality varies with depth, typically becoming poorer with depth.

Monitoring Well Installation:

- E&E has stated an approximate sample point, for each of the down gradient wells, 15 ft. horizontally from the production wellbore.
 - There are numerous potential sources of contamination, both associated with and not associated with oil development operations. CHK does not believe EPA has incorporated systematic planning into the study design to ensure the study objective can be met and the appropriate data will be collected. For example, it is not clearly identified how EPA would differentiate the potential sources of contamination.
 - Data quality objectives for modeling and use of data need to be identified.
 - Certainty of monitoring well locations will effect modeling and data use.
 - Certainty of production well location will effect modeling and data use.

- There would be a likely physical impact to monitoring wells due to proximity to production wellbore during well construction, which would compromise the study.

Option 1: Vertical Wells with Off-Pad Access

- CHK understands this option is no longer being considered.

Option 2: Horizontal Direction Drilled (HDD) Monitoring Wells and Angle Drilled Wells

- Active wireline guidance will be used to monitor the bit locations.
 - EPA should state the tolerances and accuracies of bore path required to meet its data quality objectives and intended use of data (i.e., modeling). Robert Keyes stated that the technology could be navigated within a +/- 3 ft. horizontal and vertical tolerance. However, the tolerances associated with the monitoring well drilling technology are not inclusive of all variables that could affect the total spatial accuracy.
- Minimal starting distances of 100 ft. for the 20 ft. well and 250 ft. for the 50 ft. well.
 - The minimal starting distances will complicate the land owner access agreements and assessments.
- The goal of the 20 ft. well is to intersect the top of the water table.
 - The use of horizontal wells only allows for the sampling of a small vertical interval. There is a very likely risk that the water level will change causing the water table to drop below the shallow well. A vertical well is more appropriate well type for monitoring the top of the water. In this geological setting it is not uncommon to see yearly water level fluctuations on the order of 5 to 10 feet occur.
- Development of the wells:
 - Details regarding the development of the well should be provided, included parameter stabilization requirements.
- The wells are stated to be abandoned after study/sampling activities are completed in accordance with state regulations.
 - It should be stated exactly how the wells will be abandoned. EPA should work with the state to understand its expectations. Without a clear understanding of what is required for proper abandonment, there is no assurance these requirement would not impede CHK operations at a future date.

Groundwater monitoring, purging and sampling procedures

- E&E states development of wells at least 48 hours before sampling.
 - CHK requests that the time between development of well and sampling be no less than 5 days.
- The use of pressure transducers.
 - The EPA will need to specify calibration requirements.
 - The pressure transducers in option one will not be accessible. How will the risk of equipment failure be mitigated. In addition, the use of offset monitoring wells to monitor water levels would not allow the use of the provided low-flow sampling procedure.

Pervious use of HDD Techniques for Groundwater Monitoring

- E & E has listed previous use of HDD monitoring wells.
 - CHK acknowledges HDD monitoring wells have been used on previous projects as a last alternative to monitoring groundwater quality. Note one of the examples provided choose to use HDD if the application of standard wells was possible.
 - Limited detail information could be found publically available for the examples provided, however, the information found stressed the limitation of HDD technology and completely understanding the application of HDD technology prior to use.

Re: Technical Memorandum – Revised groundwater monitoring wells in support of EPA's hydraulic fracturing study. (March 26, 2012)

Introduction

- E & E based the depth of the USDW on statements made by CHK in the meeting.
 - CHK recommends EPA and its contractors independently verify information CHK provides when possible. This recommendation is related to the public perception issues associated with the study. In addition, CHK believes it is important that both EPA and its contractors are familiar with the wealth of information the state provides to the public.
- E & E has stated, for the purposes of discussion, assumed groundwater screen intervals.
 - CHK would prefer that the logic used to determine the groundwater screen intervals are described, as well as, how this information will be collected and the quality of this information will be assured. This preference is aligned with EPA's Quality policies, procedures, and guidelines.
- E & E states that three permanent monitoring wells will be installed to characterize the site.
 - The monitoring wells may be temporary, and additional monitoring wells would be installed to increase the accuracy of the site characterization.
- E & E stated that CHK will drill, log and complete a deep monitoring well.
 - The parties have not determined that CHK will drill the well.
- E & E has stated that the need for the installation of horizontal monitoring wells will be made based on the results from groundwater monitoring.
 - CHK believes that the appropriate information will be collected to ascertain the groundwater velocity in the alluvial aquifer.
- E & E states that the application of horizontal wells will be based on the need and subject to CHK approval.
 - CHK confirms that the application of horizontal wells is subject to our approval.
- E & E states that the distance from the production well to the horizontal wells will be based on groundwater flow data during the initial monitoring period.
 - There are other variables to be considered besides groundwater velocity. In addition, determining the groundwater flow in the bedrock formation may be problematic.
 - The distance a potential contaminant from the wellbore is not limited solely by groundwater velocity. "The accelerated arrival of contaminants at a discharge point can be a characteristic feature of dispersion that is due to

the fact that some parts of the contaminant plume move faster than the average groundwater velocity” according to a report found on the National Academies Press website (http://www.nap.edu/openbook.php?record_id=1770&page=37).

- The following comments and concerns from the original February 24, 2012 Technical Memorandum remain outstanding:
 - There is not the necessity for CHK to orientate the pad to accommodate a minimum distance of 75 ft., if EPA plans to use one of the alternative well designs. The adjustment will impact CHK’s operations, and was offered to facilitate the installation of conventional monitoring wells off the pad location.
 - The limitations of the site characterization scope of work should be disclosed in terms of the information that will be able to be collected. For example, the piezometer well will not be able to determine conditions (i.e., groundwater velocity) for the proposed deep monitoring well in the bedrock formation.
 - “Water bearing zones” need to be clearly defined (e.g., USDW). The quality and quantity of water is of interest.
 - EPA should set limits, in terms of monitoring drilling capabilities (i.e., accuracy of location), for target water bearing zones.
 - We recommend EPA identify the process it will use to differentiate between potential causes (including naturally occurring) should sampling results indicate a significant change in water quality that is otherwise unexplainable.
 - We recommend data quality objectives for modeling and use of data be identified.
 - Certainty of monitoring well location will effect modeling and data use.
 - Certainty of production well location will effect modeling and data use.
 - We recommend EPA state the tolerances and accuracies of bore path required to meet its data quality objectives and intended use of data (i.e., modeling). Robert Keyes stated that the technology could be navigated within a +/- 3 ft. horizontal and vertical tolerance. However, the tolerances associated with the monitoring well drilling technology are not inclusive of all variables that could affect the total spatial accuracy.
 - The minimal starting distances will complicate the land owner access agreements and assessments.
 - The use of horizontal wells only allows for the sampling of a small vertical interval. There is a very likely risk that the water level will change causing the water table to drop below the shallow well. A vertical well, screened at intervals is more appropriate well type for monitoring the top of the water.
 - Details regarding the development of the well should be provided, included parameter stabilization requirements.
 - It should be stated exactly how the wells are to be abandoned. EPA should work with the state to understand its expectations. Without a clear understanding of what is required for proper abandonment, there is no

assurance these requirement would not impede CHK operations at a future date. Kent Wilkin and Robert Keyes had similar concerns with the lack of clarity regarding abandoning procedures.

- CHK requests that the time between development of well and sampling be no less than 5 days.
- The EPA will need to specify calibration requirements for transducers.